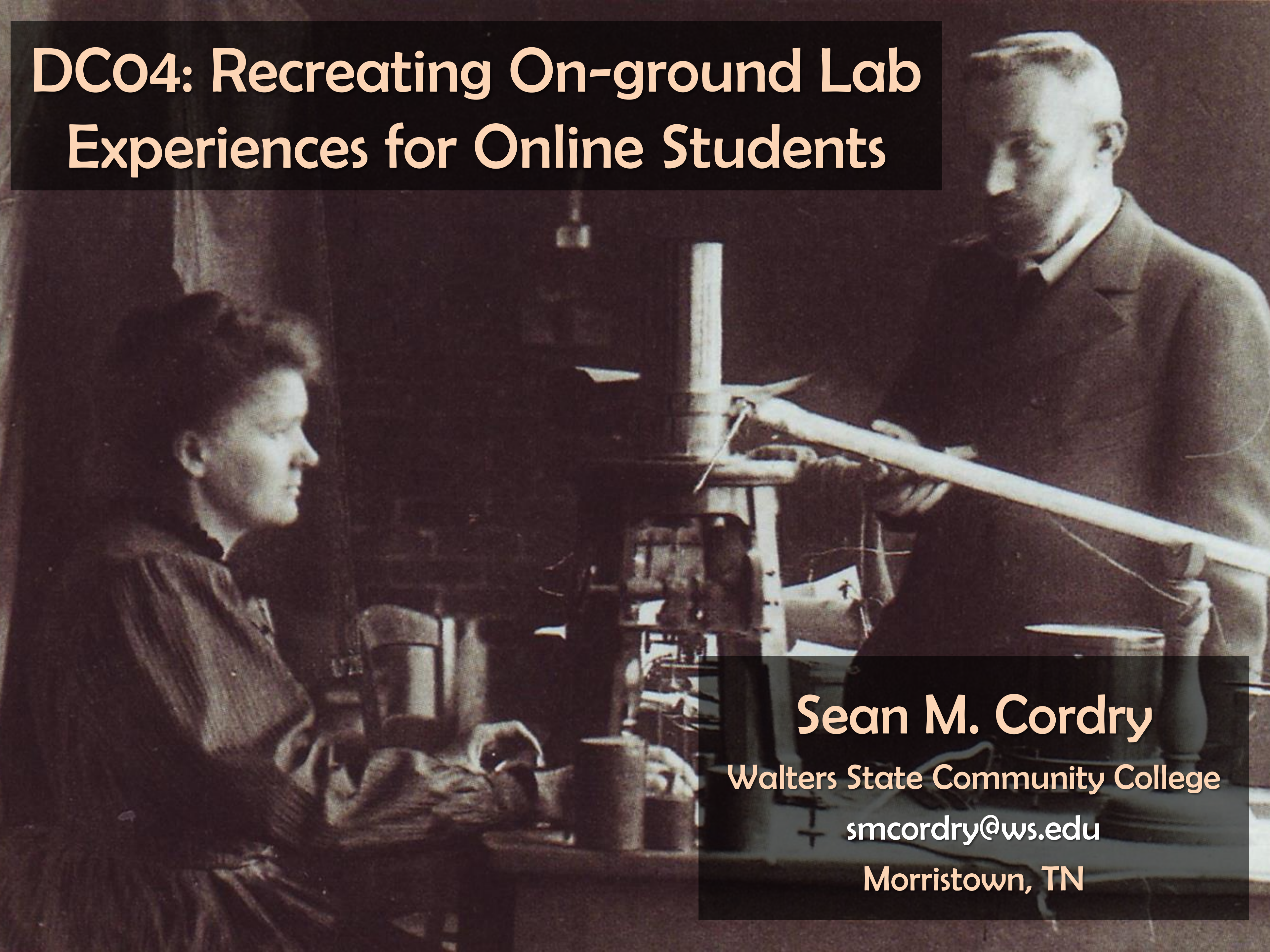


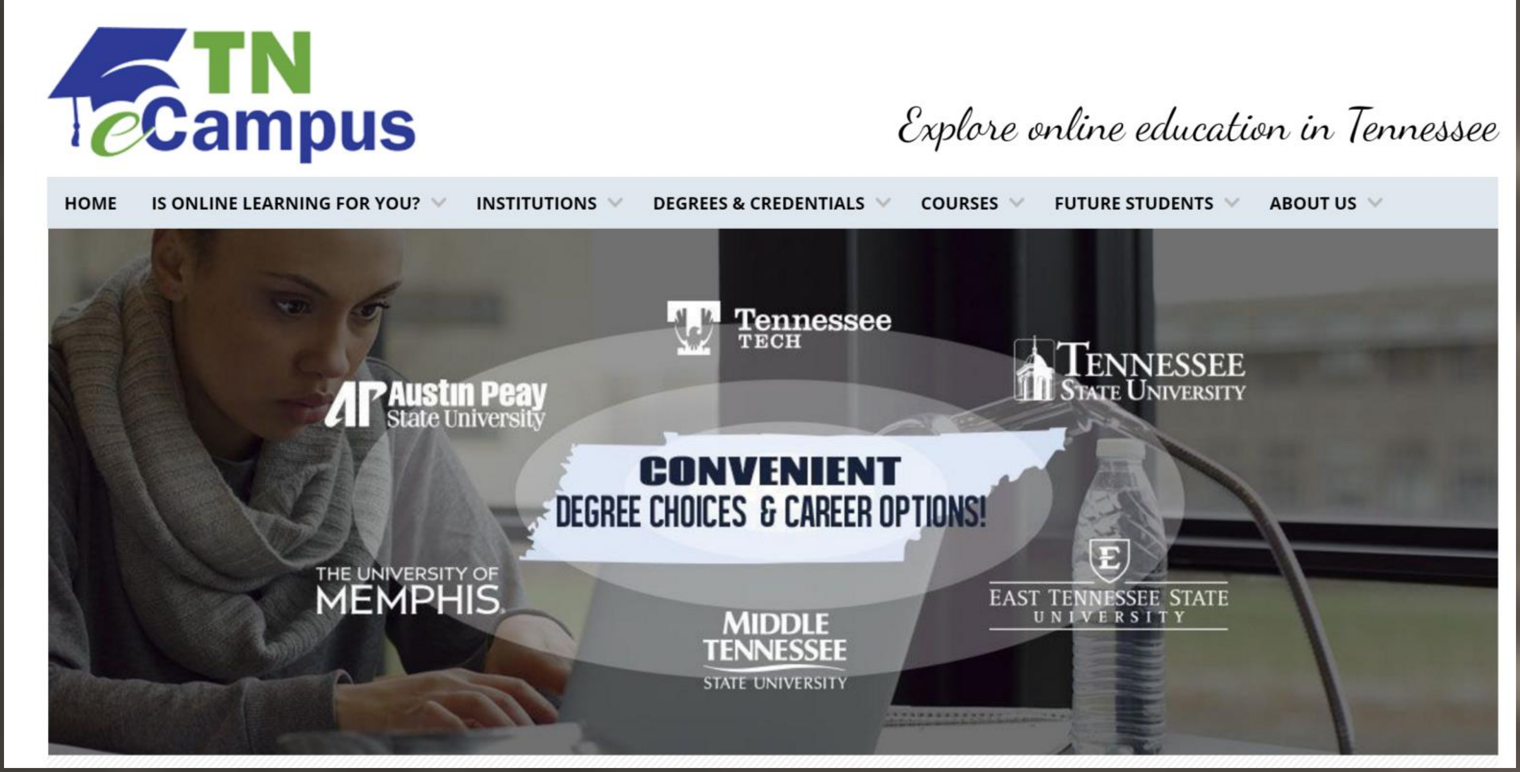
DC04: Recreating On-ground Lab Experiences for Online Students

Sean M. Cordry
Walters State Community College
smcordry@ws.edu
Morristown, TN

Context

TN eCampus

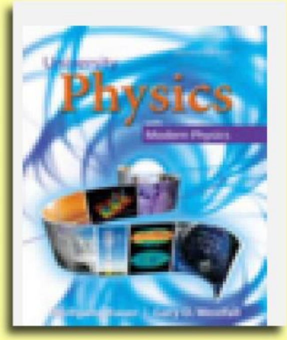
- State-wide collaborative
- 200+ students in intro calc-based
- 10+ sections/semester w/remote adjuncts



Cont

Module Structure

Acquire Intel: Study Your Text



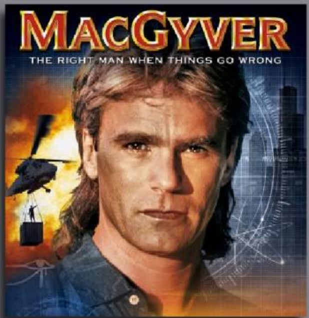
connect | PHYSICS

Homework: Master Your Knowledge

1 **Introduction to Sap**
Video: Introd
Practice Assi
HW: Math Re

sapling learning

FYI's: Get Your MacGyver On!



(Your Labs)

Test: Show What You Know

sapling learning

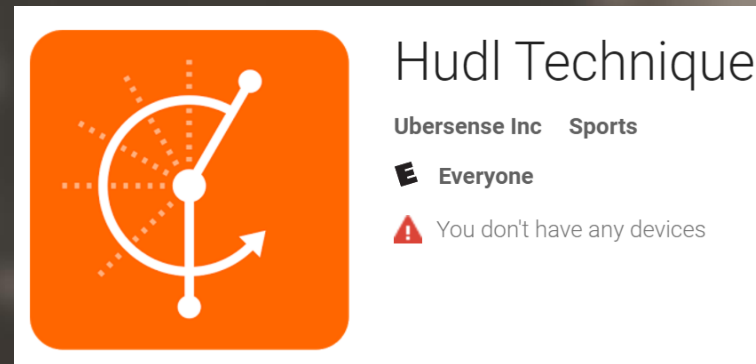
Tools: Hardware

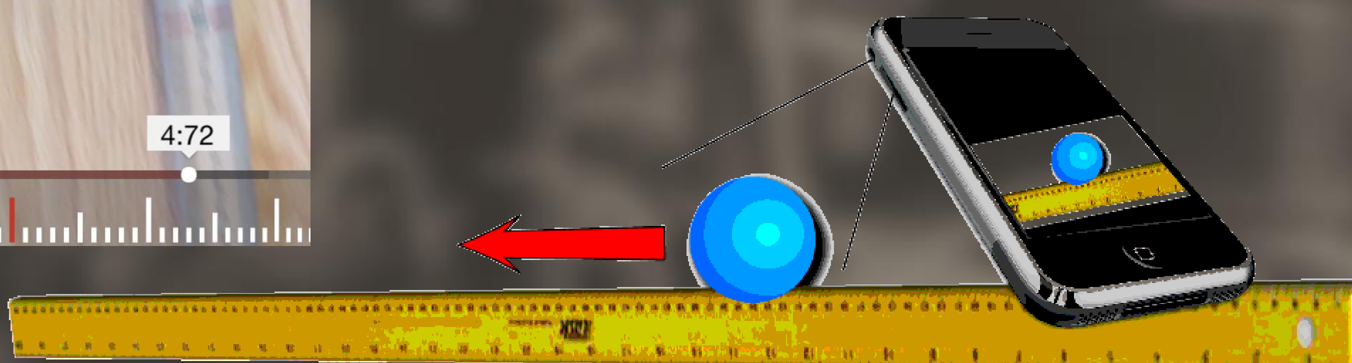
Easily available items: Walmart, Lowes, Hobby-Lobby

1st Semester
- Meter stick
- Bouncy ball
- Paper clips

2nd Semester
- String
- Washers
- Hand-held magnifier
- Bare copper wire (solid)
- Neodymium magnets

Tools: Software





Implementation: Overview

Physics I	Physics II
Bouncing Balls * *coefficient of resitution* * *distribution of data*	Galileo's Pendulum * *effect of mass and length*
The Slope of Motion * *roll ball on level surface* * *slope of position-time graph*	Camera Obscura * *measure object & image distance* * *determine focal length*
Galileo's Incline * *roll ball on inclined surface* * *slope of velocity-time graph*	Homopolar Motor **construct device* * *compare to Aurora Borealis*
Hang in the Balance * *construct balance from meter stick* * *mass of penny from mass of dime*	Photoelectric Effect **PhET simulation*

Implementation: Worksheets (1)

Galileo's Incline

This investigation is all about experiencing how constant acceleration down an incline affects both the position and velocity of the ball.

Remember: the slope of a graph is a quantity related to the steepness of a curve or line. In your last FYI, we compared the position to which a ball rolls to the time that it takes for it to go that distance, and then we made a graph. If the position-time data makes a straight line, then we know that it has a constant slope, which means that the velocity of the ball is constant. This time however, the ball will be rolling down a shallow incline, and the position-time graph of the ball will make a parabola. The slope of a parabola changes continuously, which means that the velocity of the ball is changing continuously.

Instead of only graphing the position of the ball as a function of time, we are also going to graph its velocity as a function of time. The slope of "the-slope-of-position" is the slope of the velocity, which is the acceleration.

You'll be using a smart device again to take a video of the motion of the ball. (See Fig. 1.) Using a different kind of mark (color or dashes or something), mark your meter stick at these intervals: 4 cm, 16 cm, 36 cm, and 64 cm. When the ball passes a mark, you'll note the time at which the ball passes it.

On the Simulation Tab

The second tab has simulated data along with some actual data that I did myself.

Notice that there are three graphs. (You'll eventually be taking three separate sets of data.) Each graph actually has two vertical axis – one for each set of data: position and velocity. Take a few moments to make sure that the situation makes sense to you. (Can you tell which data set goes with which axis?) The velocity has a linear trend line passing through the data points, and its equation is given. The slope of the velocity data is the acceleration value for the ball.

The first data set is completed for you. It's the data that I took using the apparatus shown in the video tour. (If you haven't watched that yet, you need to before proceeding.) The other two graphs have some missing data that you'll need to fill in. This will give you some practice before doing your real data.

What to do next:

1. Complete the missing data for the second and third data set on the Simulation tab.
2. Set up your incline and mark your meterstick at the proper positions. (See Fig. 2.)
3. Take some practice videos. Making sure that the ball rolls next to the meter stick and doesn't go bumping into it or rolling away might be a bit tricky.
4. You'll need to have three separate videos for analysis. You set the angle of your incline to whatever you like. The steepness of your incline can be the same for all three or you can mix it up. Warning: stay with a small angle; you'll be surprised at how quickly things can get out of hand if you go more than ten degrees. You might need a friend to help you out.
5. Fill out your Lab Report and turn it into the proper dropbox.

Note: You can only enter information in the cells colored yellow with the question mark.

Figure 1: Start the ball at rest at the "zero" position.

[Click here for Ubersense Coach on Google Play.]

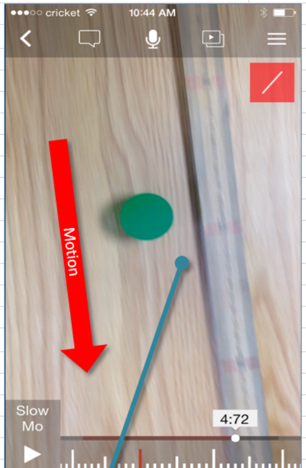
[Click here for Ubersense Coach on iTunes.]

Figure 2: Mark your meterstick at these positions: 4 cm, 16 cm, 36 cm, and 64cm.

First Tab: Intro, directions

Implementation: Worksheets (2)

Figure 3: Screen shot of video with Ubersense app.



The 0.48 meter mark.

The actual data that I obtained. (#1)

	x_1	t_1	delta-x_1	delta-t_1	v_1
1	0.00	2.61			
2	0.04	3.03	0.04	0.42	0.10
3	0.16	3.58	0.12	0.55	0.22
4	0.36	4.08	0.20	0.50	0.40
5	0.64	4.61	0.28	0.53	0.53
6	1.00	5.13	0.36	0.52	0.69

delta-x1 = difference in x1 values

delta-t1 = difference in t1 values

v1 = delta-x1 divided by delta-t1

Simulated Data Set (#2)

	x_2	t_2	delta-x_2	delta-t_2	v_2
1	0.00	2.00			
2	0.04	2.56	0.04	0.56	0.07
3	0.16	3.15	0.12	0.59	?
4	0.36	3.67	0.20	0.53	?
5	0.64	4.23	0.28	0.56	?
6	1.00	4.76	0.36	0.53	?

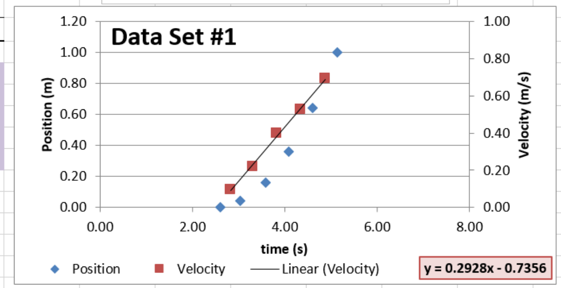
You fill in the v_2 values. If you did it right, the slope of your velocity line will be 0.274

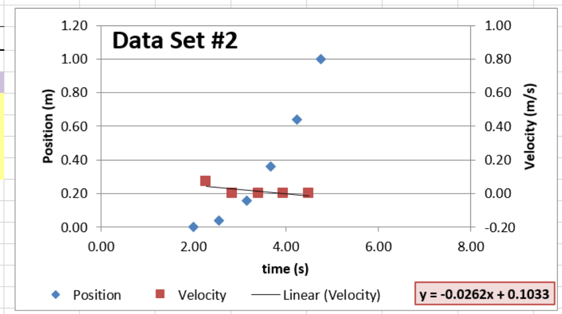
Simulated Data Set (#3)

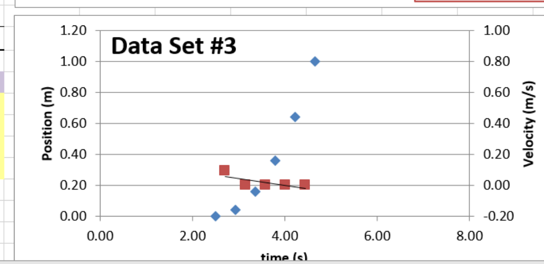
	x_3	t_3	delta-x_3	delta-t_3	v_3
1	0.00	2.50			
2	0.04	2.93	0.04	0.43	0.09
3	0.16	3.36	0.12	?	?
4	0.36	3.80	0.20	?	?
5	0.64	4.23	0.28	?	?
6	1.00	4.66	0.36	?	?

You fill in the missing values. If you did it right, the slope of your velocity line will be 0.428

Note that we have two different vertical axis. The left one is for the position of the ball, and the right one is for the velocity of the ball.







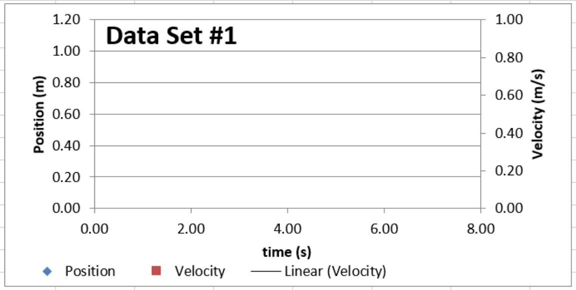
Intro | Simulation | Your Data

Second Tab: Simulated data (locked)

Implementation: Worksheets (3)

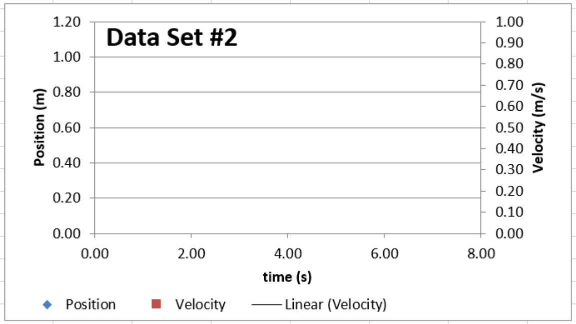
	x_1	t_1		delta-x_1	delta-t_1	v_1
1	0.00					
2	0.04			0.04		
3	0.16			0.12		
4	0.36			0.20		
5	0.64			0.28		
6	1.00			0.36		

The slope of your first velocity line is #DIV/0! m/s^2.



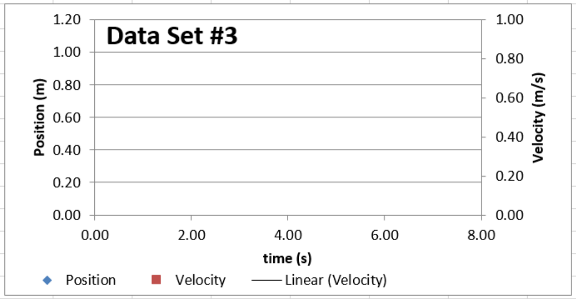
	x_2	t_2		delta-x_2	delta-t_2	v_2
1	0.00					
2	0.04			0.04		
3	0.16			0.12		
4	0.36			0.20		
5	0.64			0.28		
6	1.00			0.36		

The slope of your second velocity line is #DIV/0! m/s^2.



	x_3	t_3		delta-x_3	delta-t_3	v_3
1	0.00					
2	0.04			0.04		
3	0.16			0.12		
4	0.36			0.20		
5	0.64			0.28		
6	1.00			0.36		

The slope of your third velocity line is #DIV/0! m/s^2.



Third Tab: Their own data (locked)

Assessment (1)

Galileo's Incline

Type your name here

Pre-Lab

Answer the following questions based on the lessons on data and the instructions provided in the Excel worksheet.

Review Question		Your Answer	
Q1	What is the mathematical pattern to the new marks that you put on your meterstick?	*A1*	*Your answer for Q1 here.*
Q2	Why is it important to use small angles for your incline?	*A2*	*Your answer for Q2 here.*

Apparatus

Figure 1: Apparatus Photo	Figure 2: Apparatus in Action Photo
Caption: *Caption for apparatus picture*	Caption: *Caption for action photo*
Notes: *Additional information you might add*	Notes: *Additional information you might add.*

Results

Insert a picture of each of your graphs below. (Use the "Snipping Tool.") Specify the values of your ball's accelerations.

Figure 3: Graph of Results – Insert a separate image for each graph		
Notes: Additional note(s) about your graph.		a_1 = slope of velocity here m/s^2 a_2 = slope of velocity here m/s^2 a_3 = slope of velocity here m/s^2

Analysis and Implications

Answer the following questions based on your experience.

Analysis Question		Your Answer	
Q3	According to your first data set, how long would it take for the ball to have rolled 2.0 meters (if it could have)?	*A3*	*Your answer for Q3 here*
Q4	If the speed of a ball was 0.75 m/s at 2.0 seconds, what would be the speed of the ball at 4.0 seconds?	*A4*	*Your answer for Q4 here*
Q5	If you had started the ball at the bottom of the incline, and rolled so that it would just get to the top, what would its velocity-time data look like?	*A4*	*Your answer for Q5 here*

Additional Instructions

Convert this document to PDF format and then upload it to the appropriate dropbox.

Blank report worksheet (locked)

Assessment (2)

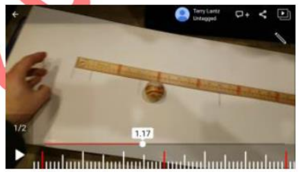
Galileo's Incline

Pre-Lab

Answer the following questions based on the lessons on data and the instructions provided in the Excel worksheet.

Review Question		Your Answer	
Q1	What is the mathematical pattern to the new marks that you put on your meterstick?	A1	*It match the formula: 4n^2, where n=1,2,3,4*
Q2	Why is it important to use small angles for your incline?	A2	*Because the you will begin to lose your parabola on the position time graph as the ball will be less affected by the incline and more affected by gravity. It also makes it harder to track using the application.*

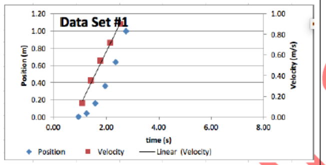
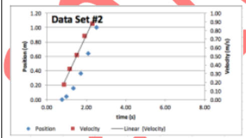
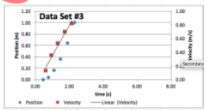
Apparatus

Figure 1: Apparatus Photo	Figure 2: Apparatus in Action Photo
	
Caption: Galileo's Incline Lab	Caption: Ball rolling down incline.
Notes: Yardstick on back of full-length mirr	Notes: *Additional information you might add.*

Selfie now required

Results

Insert a picture of each of your graphs below. (Use the "Snipping Tool.") Specify the values of your ball's accelerations.

Figure 3: Graph of Results – Insert a separate image for each graph		
		
Notes: Additional note(s) about your graph.		a_1 = .522 m/s² a_2 = .495 m/s² a_3 = .439 m/s²

Analysis and Implications

Answer the following questions based on your experience.

Analysis Question		Your Answer	
Q3	According to your first data set, how long would it take for the ball to have rolled 2.0 meters (if it could have)?	A3	*2m=.522x-.4049, x = 4.6 seconds*
Q4	If the speed of a ball was 0.75 m/s at 2.0 seconds, what would be the speed of the ball at 4.0 seconds?	A4	*1.39 m/s*
Q5	If you had started the ball at the bottom of the incline, and rolled so that it would just get to the top, what would its velocity-time data look like?	A4	*It would be an upward facing parabola, where it reaches 0 when the ball reaches its maximum height and rolls back down gaining speed.*

Additional Instructions

Convert this document to PDF format and then upload it to the appropriate dropbox.

Submitted to dropbox

Questions, discussion, suggestions